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THE COLLECTION AND CULTIVATION OF CRUDE DRUG PLANTS IN NORTH CAROLINA, WITH SPECIAL REFERENCE TO THE CULTURE OF HYDRASTIS AND BELLADONNA

By John Grover Beard.

During the past decade there has been much agitation throughout the United States for drug cultivation. This agitation produced definite results soon after the outbreak of the European war, and has now crystallized into concrete efforts upon the part of large manufacturing houses to grow in this country as many medicinal plants as supply, demand, and feasibility would dictate. The original movement for drug cultivation was started by the United States Department of Agriculture, and was soon imitated by several of the state departments of agriculture, as well as by a few private individuals here and there. The world war has now brought home to us the fact that we were dependent upon Europe not only for toys, laces, lenses, and dyestuffs, but also for a large part of our medicinal supplies. Such crude drugs as scopola, hyoscyamus, belladonna, digitalis, and ergot could no longer be obtained from Europe, and the United States had to face the problem of supplying these drugs or doing without them. With characteristic ability the country has gradually added to the supply, and while it is hardly within even a reasonable distance of the demand, it is perhaps safe to assume that, conditions constantly improving, we will at no distant time be independent of the more important European drugs.

Unfortunately, however, North Carolina, to whom nature has bounteously furnished so many drug plants, has not yet awakened to her opportunities and is year by year allowing a potential source of much wealth to rot in her fields. With her coastal plains, sand-

hill region, and mountainous districts, the State possesses not only the variety of soils and altitudes necessary for the growth of these drugs, but also a favorable climate for many varieties of what have heretofore been considered strictly European and Asiatic plants. North Carolina conservatism, which shows itself hurtfully in many other ways, is robbing our rural people of a source of income which would materially assist them in making their farming more profitable. This state of affairs must not continue longer; the farmer and his family must be shown how to augment their finances by the collection and cultivation of medicinal plants. Boys' Corn Clubs and Girls' Tomato Clubs are excellent institutions and should, of course, be encouraged, but why ignore so valuable a source of revenue as crude drug collection and cultivation would soon prove itself to be? Why not organize Juvenile Herb Clubs throughout the State? Hundreds of wild drug plants—some recognized and some unknown; some rare but many numerous; a few almost valueless but by far the greater number worth a good price, lie close at hand. Why not realize profits from them?

In the distribution of medicinal plants over the State, we have distinctly marked districts, well characterized by their flora. The peculiar growth of one district may penetrate, overlie and underlie that of another, yet the predominating character of each be sufficiently marked and striking to arrest the attention of even a careless observer. The absence of the long-leafed pine (*Pinus australis*) marks the transition from the eastern to the middle botanical district, a rough boundary being the main line of the Atlantic Coast Line Railway from Weldon down through Fayetteville. The middle district reaches westward to the base of the Blue Ridge Mountains. The western or upper district extends from this point to the Tennessee line. It is in this latter district, perhaps, that North Carolina offers the collector the greatest variety and abundance of drug plants, although the eastern and central divisions are not poor in their supply. This mountain district is as peculiar and interesting in its plant products as it is attractive in its scenery. The ascent of every one hundred feet presents new and varying species until we reach the region of the dark and sombre firs, where we have a vegetation almost entirely northern. There is also a striking peculiarity in the vegetation of these higher regions which rarely fails to attract the eye of a visitor in the profusion of grace-

ful ferns and delicate mosses that cover the slopes. These, for the most part, are identical with species found in the mountains of the northern states, and many are common to similar situations in the Old Country; some, however, seem confined to our own mountains.

Wallace Brothers established a drug firm in Statesville a number of years ago for the purpose of buying, milling, and selling crude drugs. This firm advised country merchants that they would pay good prices for certain dried plants, and the merchants in turn told the country people that they could sell roots, herbs, etc., just as they could corn and wheat. Wallace Brothers are still in business in Statesville and have done a great work for the people of the State, especially the farmers of certain western counties. There are also several farms in the mountains devoted to raising drug plants. The more pretentious of these are the Sandidge Ginseng Gardens, at Bryson City, the Waynesville Ginseng Gardens, and Toms's Farm, at Hendersonville. A few years ago S. B. Penick & Co., of New York, established a branch of their crude drug firm at Marion and are engaged in the same line of work as Wallace Brothers, of Statesville. E. G, McGuire & Co., of Asheville, are also crude drug merchants.

In spite of these activities upon the part of crude drug growers and merchants, the industry is still in its infancy and in great need of stimulation. Some of the rural schools are teaching the recognition, collection, and proper curing of a few of the more important drug plants, and doubtless this subject will be given more attention in the schools, from now on, especially schools in the mountainous portions of the State.

The following drug plants have been obtained from this State. Many of them grow naturally, many more can be readily cultivated where the demand and market price is sufficient to justify the ventures. This list does not represent all the medicinal plants which have been found in North Carolina by any means, but perhaps covers the commoner ones. Many of them are collected and sold to "patent medicine" firms:

NATIVE AND CULTIVATED DRUG PLANTS OF NORTH CAROLINA

I. *Official.*—American or Green Hellebore (*Veratrum viride*), Blackberry Bark (*Rubus villosus,* etc.), Black Haw (*Viburnum prunifolium*), Black Snake Root (*Cimicifuga racemosa*), Blood

Root (*Sanguinaria canadensis*), Boneset, Thoroughwort (*Eupatorium perfoliatum*), Burdock Root (*Arctium Lappa*), Canadian Hemp (*Apocynum cannabinum*), Castor Oil Bean (*Ricinus communis*), Cotton Root Bark (*Gossypium herbaceum*), Cramp Bark (*Viburnum opulus*), Cranesbill (*Geranium maculatum*), Culver's Root (*Veronica virginica*), Dandelion (*Taraxacum officinale*), Fennel Seed (*Foeniculum vulgare*), Golden Seal, Yellow Puccoon (*Hydrastis canadensis*), Horehound (*Marrubium vulgare*), Hops (*Humulus lupulus*), Indian Tobacco (*Lobelia inflata*), Jimson Weed (*Datura Stramonium*), Lady's Slipper (*Cypripedium hirsutum*), Male Fern (*Dryopteris marginalis*), Lilly of the Valley (*Convallaria majalis*), Mandrake (*Podophyllum peltatum*), Pennyroyal (*Hedeoma Pulegioides*), Peppermint (*Mentha piperita*), Pink Root (*Spigelia marylandica*), Pipsissewa (*Chimaphila umbellata*), Poke Root (*Phytolacca decandra*), Prickly Ash (*Fagara Clava-Herculis*), Pumpkin Seed (*Cucurbita Pepo*), Queen's Root (*Stillingia sylvatica*), Sage (*Salvia officinalis*), Sassafras (*Sassafras variifolium*), Scarlet Sumac (*Rhus glabra*), Skullcap (*Scutellaria lateriflora*), Seneka Snake Root (*Polygala Senega*), Spearmint (*Mentha spicata*), Sweet Flag (*Acorus Calamus*), Vandal Root (*Valeriana officinalis*), Virginia Snake Root (*Aristolochia Serpentaria*), Wahoo (*Euonymus atropurpureus*), White Oak (*Quercus alba*), Wild Cherry (*Prunus serotina*), Witch Hazel (*Hamamelis virginiana*), Yellow Jasmine (*Gelsemium sempervirens*).

II. *Unofficial.*—American Sarsaparilla (*Aralia nudicaulis*), Angelica Root (*Angelica atropurpurea*), Balm of Gilead Buds (*Populus candicans*), Bayberry (*Myrica Cerifera*), Bear's Foot (*Polymnia uvedalia*), Birch Bark (*Betula lenta*), Black Willow (*Salix nigra*), Blue Cohosh (*Caulophyllum thalictroides*), Blue Flag (*Iris versicolor*), Catnip (*Nepeta cetaria*), Chestnut (*Castanea denatata*), Colic Root (*Dioscorea villosa*), Corn Silk (*Zea mays*), Crawley's Root (*Corallorrhiza odontorhiza*), Deer's Tongue (*Trilisa odoratissima*), Dogwood (*Cornus florida*), Elder (*Sambucus canadensis*), Eve's Cup Plant, Fringe Tree (*Chiananthus virginica*), Ginseng (*Panax quinquefolia*), Hydrangea (*Hydrangea arborescens*), Indian Physic (*Porteranthus trifoliatus*), Indian Turnip (*Arisaema triphyllum*), Jersey Tea (*Ceanothus americanus*), Larkspur (*Delphinium consolida*), Lemon Balm (*Melissa of-*

ficinalis), Life Everlasting (*Gnaphalium obstusifolium*), Liverwort (*Hepatica Hepatica*), Mullein (*Verbascum thapsus*), Passion Flower (*Passiflora incarnata*), Pleurisy Root (*Asclepias tuberosa*), Sampson's Snake Root (*Psoralea melilotoides*), Skunk Cabbage (*Spathyema fœtida*), Solomon's Seal (*Polyganatum biflorum*), Sour Wood (*Oxydendrum arboreum*), Spikenard (*Aralia racemosa*), Squaw Vine (*Mitchella repens*), Star Grass (*Aletris farinosa*), Star Root (*Chamaelirium luteum*), Tansy (*Tanacetum vulgare*), Trailing Arbutus (*Epigea repens*), Tulip Tree (*Liriodendron tulipifera*), Turkey Corn, Corydalis (*Bikukulla canadensis*), Wafer Ash (*Ptelea trifoliata*), White Ash (*Fraxinus americanus*), Wild Ginger (*Asarum canadense*), Wild Indigo (*Baptisia tinctoria*), Wintergreen (*Gaultheria procumbens*), Wormseed (*Chenopodium anthelminticum*), Yellow Dock (*Rumex crispus*), Yellow Parilla (*Menispermum Canadense*), Yellow Root (*Xanthorhiza apiifolia*).

A few general remarks concerning the cultivation of drugs, and I shall then take up in detail two drugs which I consider well worth cultivating in this State.

While it is true that our forests are full of wild drug plants that are easily collected, it is not within the province of this paper to treat of this subject fully in view of the fact that identification methods would have to be gone into exhaustively. At a later date this phase of the subject will be presented.

The first essential for the grower to consider is the selection of a proper plot for growing the drugs. Naturally, different drugs require different soils and climates, as a result of which three or four plants should be selected for cultivation and the matter of their growth be given serious study.

In what I have to say about drug cultivation I will quote rather freely from a similar paper which appeared in the *Journal of the American Pharmaceutical Association* in January, 1914, entitled "The Cultivation of Medicinal Plants in America," by Henry Kraemer, of Philadelphia, one of the foremost authorities along this line in the United States.

Generally speaking, the cultivation is done by one of two methods: (1) plants grown from seeds, and (2) propagation by cuttings. Since the former plan is the simplest one for the beginner, I shall deal first with it.

PLANTS GROWN FROM SEEDS.

When plants are grown from seeds it is necessary to begin the germination of the seed early in the spring. This should be done either in the house or under conditions where there is some protection. The seeds may be sown in flower beds in which the soil is quite sandy, clean and free from organic matter which is likely to cause mold. The seed should not be planted too deep, and should be covered with glass so as to hold the moisture. The germination period varies considerably. If quick germination is desired, the simplest plan is to place the seeds in water for 24 hours; or, if a tough seed coat is being dealt with, germination may be hastened by pouring hot water upon them, or some special treatment may be given them, such as the use of dilute mineral acids. After the seedlings have a few leaves upon them they should be set out in suitable boxes known as "flats." These boxes should be about three inches deep and about two feet square, and the soil—which again should be sandy—should have added to it a certain amount of nutriment. Care must be taken to ward off the attacks of micro-organisms in the soil. Some special method is necessary for overcoming this. Dilute sulphuric acid has been utilized for this purpose by the Department of Agriculture. The seedlings are allowed to grow in the "flats" until they have developed a good root system and have three or four leaves. Before putting them directly in the soil out of doors, they may be hardened, if thought desirable, by placing them in cold frames. This transfer should be made not later than the early part of May. Practical gardeners are familiar with such frames. When the plants are transplanted out of doors it is very desirable that this be done as quickly as possible after the last frost. The plants are arranged in rows sufficiently far apart for "weeding" and working, so that the maximum crop per acre can be obtained. Such plants as belladonna, hydrastis, and ginseng are easily grown by this method.

PROPAGATION BY CUTTINGS

This is a common method of propagatng plants. A "cutting" is a severed portion of a stem, having one or more nodes or buds. They are derived either from above-ground shoots, as in geranium, or from the root stocks, as in the case of hydrastis. In the case of

both ginseng and hydrastis, one-year-old plants are frequently supplied by growers, and while, everything considered, this is not desirable, yet for experimental purposes this method may be employed.

COLLECTION AND DRYING

The season at which drug plants are collected varies with each particular plant. It is important for the grower to determine the proper season for collection, since the active matter contained therein is present in small quantities at certain seasons and in maximum amounts at others. For instance, experiments thus far seem to show that belladonna leaves collected in July and August show a higher alkaloidal per cent than those gathered in September or October. The United States Department of Agriculture will supply information as to the proper season for collecting the important drug plants.

Too much attention cannot be given to the proper methods of drying, especially with the root and fleshy fruit drugs. This must generally be done in a specially prepared room, which can be equipped at small cost.

RELATIVE VALUE OF DRUGS FROM CULTIVATED AND WILD PLANTS

It has long been questioned whether the activity of drugs derived from cultivated plants is equal to that of those derived from wild plants. Some foreign pharmacopœias require that the wild plant of digitalis and belladonna be used, the inference being that the wild are preferable to the cultivated. However, in 1907, Mr. Rippetoe's experimental work in Virginia showed that cultivated plants of belladonna yielded both leaves and roots which were equal, if not superior, to the average drug on the market. These results were published in the *American Journal of Pharmacy* for November, 1907. Carr (*Amer. Jour. Phar.*, December, 1913), has shown, also, that cultivated belladonna has a greater toxicity than the wild plant. Carr states that nitrogenous manures tend to lower the percentage of alkaloids, and Miller reports (*Amer. Jour. Phar.*, July, 1913) having grown belladonna plants with commercial acid phosphate and obtained a yield of alkaloids as high as 0.9 per cent. He has obtained similar results with wild and cultivated plants of stramonium. The experiments conducted in Summerville, S. C.,

by the United States Department of Agriculture have shown that in that locality *Cannabis indica* (Indian hemp), of a somewhat high degree of potency, can be cultivated. The development of the tea industry in South Carolina is one of the most creditable pieces of work of the National Government. Bulletitn No. 234 of the Bureau of Plant Industry, on the "Cultivation and Manufacture of Tea in the United States," should serve as an inspiration to anyone contemplating drug culture. If a plant of this kind can be grown successfully here and the technique of manufacture developed to such an extent that the cultivation in South Carolina has become remunerative, there is no reason why the majority of the drug plants—except the strictly tropical ones—cannot be successfully grown in the United States, and 75 per cent of these in North Carolina. Experience has shown that cultivated crops command a higher price than the drugs obtained from wild plants, even though their superiority cannot always be demonstrated by analytical means. The improvement of a plant from the standpoint of the active matter which it contains may be effected by continually selecting for propagation such plants as conform most closely to the ideal sought, by the selection of spontaneous variations or sports, and by hybridization. Breeding, or cultivation, has been slow because of ignorance upon the part of the grower, upon the quality of drug plants sought, and, also, because not many people possess knowledge of what drugs are required or what kind of soil and climate is best adapted to the different species.

The time allowed for the presentation of this paper permits a discussion of the cultivation of only two important drugs, Hydrastis and Belladonna.

HYDRASTIS.

(Synonyms: Golden Seal, Yellow Puccoon, Indian Dye or Turmaric, Jaundice Root, and Orange Root.)

Golden Seal, so called by reason of the yellow seal-like scars on the fleshy rhizomes, was once abundant in wooded portions of Ohio, Indiana, Kentucky, and West Virginia, and, to a less extent, was found in the western part of this State. Its natural location is in rich, open woods where leaf mold is abundant. The drug was discovered in 1793 and was made official in the United State Pharmacopœia of 1860. Its original cost was 10 cents a pound; it now

costs about $5 a pound and yields the grower from $3 to $4. It is easily cultivated and thrives best in rich, soft, loamy woodlands, and should at all times be kept free from grass. If a wooded tract is not available, artificial shading should be supplied. Hydrastis lives from four to six years, the rhizomes becoming weaker with age. The propagation should be by cuttings. The matured rhizomes contain many rootlets and undeveloped buds. Just as each "eye" in a potato will produce a new plant, so will each bud on the rhizome provide a young shoot, if only the root be left with it. In propagating the plant, the rhizomes should be sliced transversely into several parts, each having its bud and a few of the fibrous roots, and these should be planted a few inches apart, in rows, in shaded, grass-free beds containing suitable moist soil. The young plants will show a quick, thrifty growth. Many cuttings which apparently die, spend their first year in budding up a good root and bud system, and the second season will bring forth vigorous young plants. The rapid rate at which an hydrastis bed may be increased by means of cuttings is indicated by the fact that one old root will yield about five eye-cuttings, each with rootlets. The cuttings should be planted about one inch beneath the soil, a few inches apart, and allowed to remain for two years and then transplanted into rows or a bed. The parent rhizome (four to six years old), after the leaf has withered but can still be located, should be lifted from the earth and three-fourths of it cut off, the growing end bearing the terminal bud replaced in the earth, thus leaving in the bed the full-grown plant to continue the life of the bed. Hydrastis rapidly depletes the soil, which should be replenished either by well-mulched horse manure, henyard refuse, wood ashes, butcher-shop waste, or barn manure, worked into an artificial soil. Wild soil should not be added because of the contamination of insects and other pests, such as worms, snails, etc. The plants should be occasionally sprayed with Bordeaux mixture.

ATROPA BELLADONNA

(Synonyms: Deadly Nightshade, Black Cherry,. Great Morel, etc.)

The United States Pharmacopœia recognizes the leaves and roots of this plant and specifies that the leaves shall assay not less than

0.35 per cent and the roots not less than 0.45 per cent of mydriatic alkaloids such as atropine, belladonine, hyoscyamine, and hyoscine.

Belladonna is an old drug which was known to the ancients. It derives its name from two Italian words, "bella," beautiful, and "donna," lady, *i. e.*, the berries were used by Italian ladies as a cosmetic., and to dilate the pupils of the eyes, thus rendering them more beautiful and handsome.

Belladonna is a bushy, strong-growing, perennial herbaceous plant, with a fleshy creeping root from which arises several erect, round, purplish branching stems to the height of about three feet. There have been many efforts put forth during the past ten or fifteen years to grow the plant upon a commercial scale in this country, but up to the present time but few growers have been successful from a financial standpoint. The cost of production has equaled or exceeded the selling price. The development of the industry consequently has been slow, in many cases expensive, and at times so discouraging as to almost cause its complete failure and subsequent abandonment. However, the European war has practically cut us off from our former supply and prices, as a result, have reached such figures as to promise a great stimulus to former cultural efforts, and should go far toward seeing belladonna put upon a paying basis as a cultivated drug in the United States. The Bureau of Plant Industry of the United States Department of Agriculture has furnished growers with the experience gained from exhaustive cultural experiments, and, in addition, such firms as Sharp & Dohme and Parke Davis & Co., have given to the public the results of their efforts to cultivate this valuable drug. With these facts, suggestions, and cautions against previous mistakes, vigorous efforts will undoubtedly be made by growers to furnish pharmacy with a supply of the home-grown drug.

A discouraging feature of belladonna cultivation is the long period of time required for the seeds to germinate, four to six weeks being a minimum time even under greenhouse conditions. The plant requires rich, moist, calcareous soil with ample atmospheric moisture. The temperature should never go below 10° F. in a region where belladonna is to be grown unless the tedious process of hardening the young plants is resorted to before they are transplanted to the open fields. In North Carolina, where such a

low temperature never prevails during the growing season, the seeds may be germinated in large, shallow boxes, provided with glass covers to conserve the moisture, and the young plants may be transplanted to the desired plot, spacing the plants three by three feet. With this spacing, approximately forty-seven hundred plants can be set out to the acre. Subsequent cultivation for belladonna may be about the same as for corn until the plants begin to branch, when some form of a single plow must be adopted. In the meantime the crop must be protected from insects and plant diseases. The common potato beetle is the insect which must be constantly fought, and curbing efforts should be resorted to during the earliest stages of growth. If arsenical solutions are employed at this early period, the leaves which have been sprayed will drop off before maturity, and this eliminates danger of arsenic being present in the leaves and roots when they are collected for the market. Plant lice can be eliminated by tobacco sprays, which are harmless. The young plants should be watered frequently.

According to Rippetoe the leaves should be collected in July or August to insure the greatest alkaloidal yield, for after that the contents begin to decrease. Whether the alkaloids are lost during the later plant processes or are returned to the root is a question. The latter inference has much weight with many authorities. In fact it is generally advised that the leaves should be pulled in July or August of the second year, and the roots in the fall of the fourth years' growth, the seeds for future propagation being of course gathered in the fruiting season.

Belladonna is now (January, 1916) bringing $2.00 per pound. Since there is no apparent relief in sight from the present belladonna famine, and because of the fact that this is a much-needed drug plant, it is urged that cultural methods be begun in this State.

A fact upon which emphasis should be laid is that heretofore the drug has been cultivated in the northern states where the climate is somewhat too rigorous. In North Carolina it would doubtless be profitable to raise the drug, since we have a temperate climate, the kind of soil necessary, a six or seven months growing season, and only an insignificant fall weed crop.

The following plants could probably be cultivated successfully in North Carolina, though there is not sufficient evidence to justify a positive statement.

Arnica montana. Abundantly used, easily grown in almost any soil, but cost of labor might prevent profit.

Capsicum fastigiatum. Has a limitless demand as native sources have about become depleted. Bears continuously in Florida; should be successfully cultivated here.

Cascara Sagrada (Rhamnus Purshiana). Grows well around Washington, D. C., and would doubtless thrive in the sandy soil of southern North Carolina. Amount of the bark used is almost incredible and native supplies are almost exhausted; hence it must ultimately be cultivated. Seeds can be readily obtained. It will grow well in any soil.

Cannabis indica (Hashish, etc.). At present the Pharmacopœia requires that the East Indian variety be employed, but likely the forthcoming issue will allow the naturalized form (*Cannabis sativa*), which has been proved to be even more active. Should this permission be granted the drug could be easily and profitably raised here.

Colchicum officinale. Very largely used, seed and corn being official; easily grown; price is rather low. Requires a rich, light soil.

Conium maculatum. The fruit is used and is valuable in medicine. It is grown in the field like wheat or rye, and harvested in a similar manner. Its culture in this country has probably never been attempted, but since other species of this genus grow wild in our fields there is reason to suppose the *maculatum* would also grow here. The drug as at present obtained is liable to adulteration, and a clean, pure supply would be eagerly received.

Digitalis purpurea. Largely used, fair prices paid. Plant seed in drills and transplant to fields when well established; set in rows two feet apart and plants separated by eighteen inches. Gather leaves during commencement of blooming period and dry carefully in shade.

Claviceps purpurea (Ergot). A parasitic fungus, replacing the grain of rye, a pound being worth as much as two bushels of rye. It has never been practically established in this country as yet, but is well worth experimenting with.

Rhamnus Frangula (Frangula, Buckthorn). Can be easily grown in swamp lands, replacing ordinary brook-alder. Is abundant

and cheap, but often adulterated, and manufacturers would be glad to get their supply from cultivators who could insure purity.

Artemisia pauciflora (Santonica). Greatest difficulty would be collecting seed from a reliable source, as the present supply comes from Turkey, but the experiment is well worth trying. A brand known to be pure would bring a high price, as santonica is largely used for the extraction of santonin, and for two years the genuine has been scarce and expensive.

Pimpinella Anisum. Will not grow as far north as New York, but could perhaps be grown in this State.

This list does not include the indigenous North Carolina plants, as it goes without saying that their cultivation would be relatively easy. The Government publications listed below will be of much help to the prospective drug cultivator.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE ON DRUG PLANTS, ETC.

PUBLICATIONS AVAILABLE FOR FREE DISTRIBUTION.

Weeds Used in Medicine. By Alice Henkel. Pp. 45, figs. 31. 1904. (Farmers' Bulletin 188.)

Growing and Curing Hops. By W. W. Stockberger. Pp. 39, figs. 20. 1907. (Farmers' Bulletin 304.)

Harmfulness of Headache Mixtures. By L. F. Kebler, F. P. Morgan, and Philip Rupp. Pp. 16. 1909. (Farmers' Bulletin 377.)

Habit-Forming Agents: Their Indiscriminate Sale and Use a Menace to the Public Welfare. By L. F. Kebler. Pp. 19, figs. 5. 1910. (Farmers' Bulletin 393.)

The Cultivation of American Ginseng. By Walter Van Fleet. Pp. 14, figs. 3. 1913. (Farmers' Bulletin 551.)

Golden Seal Under Cultivation. By Walter Van Fleet. Pp. 15, figs. 5. 1914. (Farmers' Bulletin 613.)

The Source of the Drug Dioscorea, with a Consideration of the Dioscoreæ Found in the United States. By Harley Harris Bartlett. Pp. 29, figs. 8, 1910. (Bulletin 189, Bureau of Plant Industry.)

Some Effects of Refrigeration on Sulphured and Unsulphured Hops. By W. W. Stockberger and Frank Rabak. Pp. 21. 1912. (Bulletin 271, Bureau of Plant Industry.)

PUBLICATIONS FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS.

The Adulteration of Drugs. By Lyman F. Kebler. Pp. 251-258. 1904. (Separate 331, from Year Book of the Department of Agriculture, 1903.) Price, 5 cents.

Peppermint. By Alice Henkel. Part 3, pp. 19-29, figs. 3. 1905. (From Bulletin 90, Bureau of Plant Industry.) Price, 5 cents.

Wild Medicinal Plants of the United States. By Alice Henkel. Pp. 76. 1906. (Bulletin 89, Bureau of Plant Industry.) Price 5 cents.

American Root Drugs. By Alice Henkel. Pp. 80, figs. 25, pls. 7. 1907. (Bulletin 107, Bureau of Plant Industry.) Price, 15 cents.

The Sources of Arsenic in Certain Samples of Dried Hops. By W. W. Stockberger. Part 4, pp. 41-46. 1908. (From Bulletin 121, Bureau of Plant Industry.) Price, 5 cents.

American Medicinal Barks. By Alice Henkel. Pp. 59, figs. 45. 1909. (Bulletin 139, Bureau of Plant Industry.) Price, 15 cents.

American Medicinal Leaves and Herbs. By Alice Henkel. Pp. 56, figs. 36. 1911. (Bulletin 219, Bureau of Plant Industry.) Price, 15 cents.

The Diseases of Ginseng and Their Control. By H. H. Whetzel and J. Rosenbaum. Pp. 44, figs. 5, pls. 12. 1912. (Bulletin 250, Bureau of Plant Industry.) Price 15 cents.

American Medicinal Flowers, Fruits and Seeds. By Alice Henkel. Pp. 16, figs. 12. 1913. (Bulletin 26, U. S. Department of Agriculture.) Price, 5 cents.

Wild Volatile-Oil Plants and Their Economic Importance. I.—Black Sage; II.—Wild Sage; III.—Swamp Bay. By Frank Rabak. Pp. 37, figs. 6. 1912. (Bulletin 235, Bureau of Plant Industry.) Price, 5 cents.

CHAPEL HILL, N. C.

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